FIRE

Project title:	**Fire - A Force for Change and Regeneration in Natural Ecosystems: An Instructional Module**

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Objective: To study natural regeneration of lodgepole pine and other vegetation following fires of varying intensity and to document the magnitude of change through time. Also to document pre-fire conditions in selected sites, compare pre-fire and post-fire landscapes following the 1988 fires, develop teaching modules for biology and plant community ecology courses.

Findings: This is the 11th year of the project, and during that time, I have established six sites for monitoring the annual changes in growth and reproduction of lodgepole pine. This includes collecting data on yearly growth rates of saplings and the onset and rate of reproduction in saplings. In addition, 14 photographic sites have been established in areas subject to different burn intensities. These sites are re-photographed every three years to record changes in the vegetation since the 1988 fires. Also included are sites in the Lamar backcountry that were studied in 1966-67, and were subject to varying burn intensities. Other post-fire sites were initially photographed in 1959-1967 and have since been re-photographed following the fires to demonstrate the magnitude of change. All information generated to date has been incorporated into fire ecology teaching modules for biology and plant community ecology courses.

Project title: **Post-Burn Resource Selection, Physiological Condition, and Demographic Performance of Elk**

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Objective: The primary objective of this research is to evaluate the consequences of the 1988 fires on elk resource selection. Selection is being quantified for populations and individuals at multiple scales ranging from selection of patches within the landscape mosaic to selection of forages and plant parts within patches. The physiological and demographic consequences of observed resource selection strategies are being assessed through noninvasive urinary and fecal assays, and telemetry. Secondary objectives include basic research on forage plant chemical compositions, plant-animal interactions and applied research to develop practical and rigorous management tools for population monitoring (aerial surveys, fecal steroid pregnancy assays, and snow-urine condition indices).

Findings: We have been successful in developing, testing, and applying a suit of research tools that is significantly enhancing our ability to address questions of animal resource selection and the physiological and demographic consequences of selection patterns. We have completed our eighth field season of data collection and maintain an instrumented population of 30-40 cow elk. Most publications to date have focused on techniques including population estimation, pregnancy assessment, and nutritional indices. This year we completed a manuscript analyzing the demographic data collected during the first seven years of research which is currently being considered by J. Appl. Ecol. Adult survival and reproduction is near the biological maximum for the species, but recruitment is highly variable, being strongly influenced by environmental variation, primarily winter severity. Despite this variable recruitment, extensive Monte Carlo simulations indicate that the population is relatively stable and is being regulated at approximately 600-800 animals. We have generated a database of greater than 7500 animal locations and are exploring a variety of analytical tools for the analysis of these data. An ArcView GIS database has been developed that integrates landscape features with all spatially-explicit databases collected on this study. We are currently developing spatially-explicit snowpack models in collaboration with NASA scientists to enhance our analyses of elk resource selection.

Project title: **Impact of Fires of 1988**

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Objective: Annual studies of foliage, ash, and soil to track the changes in physical and chemical properties of collected materials. Sleve tests of ash and soil. Visual microscopy of ash and soil separates. Photographic records of selected sites, measurement of ash layer, description of site.

Findings: The sites on level terrain for the most part continued to reveal an average of 0.5 inch of black ash with small variation year by year. These sites were on forested terrain. Deviation from this result occurred on slopes that were washed by rainfall and on coarse soils in open terrain exposed to wind. Most dramatic is the marked increase of grasses, shrubs, and plants in the sites of level terrain in wooded areas containing considerable moisture.

Project title: **Yellowstone Post Fire Effects Plot Installation**

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Objective: The goal of the Yellowstone fire effects program is to monitor immediate post-fire and long-term trends in vegetation and fuel loading from prescribed and natural fires in the park. This year, 15 fire effects plots were established in Yellowstone at Electric Peak (8), Grant (6), and Rescue Creek (1) proposed burn units. These plots will be re-visited two months and two, five and ten years post-fire. Results will be used from burned plots and control plots to validate prescribed fire goals and objectives, refine burning prescriptions, improve fire prediction models, and monitor the effects of natural fires on vegetation.

Findings: None of the plots installed in 1999 were burned or ignited, though at least six plots (in the Grant unit) are proposed for 2000. Post-burn data is obviously not yet available, however some baseline data on fuel loading and vegetative components were generated from the initial read. Species lists and

specimen collections were created to assist with field identification.

For each plot, data such as fuel loading (tons/acre) by size class, mature tree diameters, seedling counts, duff and litter depths, relative cover of species, percent of native and non-native species, brush density and age by species, tree damage, and stems per acre were collected and analyzed. Changes in this baseline data will be measured and additional variables (such as mortality, scorch height, and burn severity) will be monitored post-burn (within the next five years).

Project title:	**Postglacial Fire Frequency and its Relation to Long-Term Vegetational and Climatic Changes in Yellowstone National Park**
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Objective: The primary objective has been to study the vegetational history of Yellowstone and its sensitivity to changes in climate and fire frequency. To establish a vegetational history, a network of pollen records, spanning the last 14,000 years, has been studied from different types of vegetation within the park. A reconstruction of past fire frequency is based on information gained from: 1) a study of the depositional processes that incorporate charcoal into lake sediments; 2) a comparison of charcoal and dendrochronologic records of fire occurrence during the last 750 years; and 3) an analysis of charcoal, pollen, and magnetic properties in lake sediment cores spanning the Holocene and late-glacial periods.

Findings: Progress was made on three aspects of this project. First, revision of the Trail Lake record is underway, based on the results of radiocarbon dating and tephra analysis, which indicate that the Trail Lake record is only 8,000 years old. The results of the charcoal, pollen, and magnetic susceptibility analysis using this revised chronology were presented at the 5th Biennial Science Conference on the Greater Yellowstone Ecosystem, and at annual meetings of the Ecological Society of America and the Geological Society of America.

Analysis of the sampling of modern sediments in lakes with watersheds that were burned in 1988. This process-based study provides information necessary to interpret the charcoal record in sediment cores, by determining the time of charcoal accumulation following a fire event. The study is unique, and the results have been used by fire researchers around the world. The samples are being evaluated in light of previous results and are discussed in two manuscripts that describe charcoal depositional processes.

Third, we are collaborating with scientists from the U.S. Geological Survey to evaluate the

paleolimnologic response of Yellowstone lakes to past climate change. Samples have been analyzed for sediment geochemistry. Special attention has been directed to northern range lakes, particularly Crevice Lake, which has annually laminated sediments. Plans are underway to core Crevice Lake in 2000. Other accomplishments of note are: 1) acceptance of the fire history from Cygnet Lake in *Geology*; 2) submission of manuscript on the paleoecologic record of plant invasions to *Western North American Naturalist*; 3) acceptance of two chapters on charcoal methodology; 3) submission of a chapter on the prehistory of the Rocky Mountains, with an emphasis on the Yellowstone region. Chapter will appear in *Rocky Mountain Futures*; and 4) presentation of results at the Biennial Scientific Conference in Yellowstone in October 1999, and at annual meetings of the Ecological Society of America, and the Geological Society of America.

Project title:	**Assessment of Secondary Mortality in Lodgepole Pine Stands in Yellowstone National Park Using LANDSAT Data**
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Objective: 1) Quantify and map the spatial distribution of secondary lodgepole pine mortality in Yellowstone National Park resulting from mixed burns or underburns. 2) Model the additional lodgepole pine tree mortality detected in 1991 based on changes in spectral characteristics of LANDSAT imagery between 1991 and 1988 as well as factors such as soil parent material, topography, site and stand characteristics. 3) Validate the mortality model through the use of color and infrared aerial photos and field data gathered from line transects.

Findings: From preliminary fieldwork in the summer of 1999, we identified a heterogeneous burned area about 9,300 ha in size located in the Lakes Region and in the old Snake River Complex Fire of 1988. This is a high elevation plateau at about 8,200 feet and is near a grizzly bear management area. It is an ideal area containing vegetation that exhibits various stages of lodgepole pine mortality. From aerial photography, we were able to determine exact locations of future survey lines to be established during the summer of 2000. We also field checked for validation previously developed secondary lodgepole pine mortality classes that had been delineated from 1:24,000 scale color aerial photos. Additional attempts were made to acquire previous research and field data that would prove useful as auxiliary data to our project. We have performed some preliminary image processing to generate NDVI and wetness index maps. By keeping an updated list of relevant literature, we are informed about the latest in remote sensing which will help guide our research towards completion. In future months, we plan to continue our visits to Yellowstone to meet with park officials, continue collecting resources, acquire other useful data sets, and interpret aerial photos, which will prepare us for our summer fieldwork.